Strategic Approach through Equipment Engineering System (EES) at Sony Semiconductor Kyushu

- Masanori Okayama
Kazutaka Mishima / Toshiya Hirai / Masahiro Makita
Masanori.Okayama@jp.sony.com
Sony Semiconductor Kyushu Corporation
4000-1 Haramizu, Kikuyo-machi, Kikuchi-gun, Kumamoto, 869-1102 Japan
Phone: + 81 -96-292-6668

1. Preface

Sony's long association with semiconductors started in 1954, when the company successfully created Japan's first prototype transistor. This history continues up until the present day with our cutting edge semiconductors, such as the MOS LSI/CCD/CMOS image sensor. Sony Semiconductor Kyushu is the part of the Sony group mainly concerned with the production of those state-of-the-art semiconductors. The predecessor to Sony Semiconductor Kyushu, called Sony Kokubu, started in 1973 in Kokubu City (now Kirishima City), Kagoshima Prefecture. Thereafter, Sony factories were established in Oita and Nagasaki to form three subsidiary companies in Kyushu, all producing semiconductors. These companies merged in April 2001 and Sony Semiconductor Kyushu was born.

The full expansion of EES throughout Sony Semiconductor Kyushu has meant that we carried out implementations on most of the processing equipment at the Nagasaki Technology Center, thus enabling us to carry out exhaustive equipment control. Meanwhile at our Kumamoto Technology Center, which commenced operations in November 2001 as a production base for imaging devices, we have been able to put full-scale process control into practice from start-up thanks to EES.

2. EES Introduction

Predicting that the significance of equipment control would become even more acute due to a shrinking of process margins brought about by miniaturization, we planned for the gradual introduction of EES to both our preexisting and new lines from 2001 onwards.

We first rolled out EES to a few dozen pieces of equipment, as shown in Fig. 1. However, we were unable to achieve results immediately after introduction, so we were forced to thumb through changes in equipment performance and relevance to processes and then develop EES, whilst all the time fighting against a flood of "noise".

On top of this, maintenance for bands set for each separate recipe required a vast amount of man hours, which meant that at first maintenance members' motivation naturally dropped and EES expansion did not pick up as we would have liked it to.

It was at this time that the top management had quality control and equipment maintenance examine the situation using the EES data so as to become fully aware of engineer operations. Thereafter, results gradually started to emerge, which led to an improvement in people's opinion of EES. Thanks to the actions of the top management, we succeeded in raising the level of motivation among maintenance members.

Let's look at an example of EES. As shown in Fig. 2, we have succeeded in overcoming "trick" measurements which occur when the standard sensor on a piece of equipment gives a false reading. We overcame this problem by adding another sensor solely for surveillance alongside the standard control sensor. With this so-called 'equipment signal' system, we are able to double-check results in order to ensure product quality.

In order to effectively set the control model in EES, it was vital for the process engineers and equipment engineers to work in cooperation. This is because separating the characteristic factors of equipment and processes in a step-by-step fashion was effective for narrowing down signals and adding further sensors, both of which are linked to results. This can be seen in Fig. 3.

3. Example of EES Results

Using EES, we are able to heighten control performance via mathematical statistical processing rather than equipment interlock devices.

Let's look at an example. Looking at Fig. 4, we detected that the piping at the back of the pump on Ti CVD equipment was blocked and so we managed to take preventative measures against pump failures and quality defects. However, by accurately grasping the behavior pattern of the pressure using EES, we were able to pick up on a change in equipment which we would not be able to detect using interlock.

Now let's look at Fig. 5. By carrying out PLS regression on data collected by EES from the etching equipment, we predicted the equipment's etching rate and managed to implement reductions in equipment quality control (QC).

When starting up our cutting-edge 300mm line, we put Enhanced Equipment Quality Assurance (EEQA) into practice in cooperation with the equipment supplier. By analyzing the equipment start-up data in great detail, we were able to pinpoint issues such as variation in the exhaust capacity of the cryopump in the ion implantation equipment and replace faulty units with fully operational ones. This meant that we were able to promptly start up the new line without affecting the prototypes. All of this was possible because we were able to clearly pick up on minute unit behavior patterns using EES that would have been very difficult to spot through the initial equipment inspection used up to now. This is shown in Fig. 5.

4. Summary

Our equipment engineers and process engineers came together as one to tackle changes in equipment performance and relevance to processes one by one, whilst all the time fighting against a flood of “noise”. Thanks to their tireless efforts, we were able to produce a living EES.

By expanding the number of members involved with the project and allowing each individual member to grow and develop, equipment/process control using EES has come to be the company’s principle line concept.

With this, we are now able to expand ESS throughout the entire company, which without a doubt led to massive achievements.

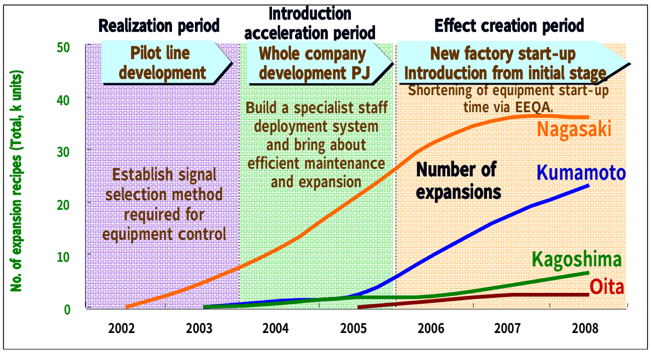

Fig. 1 The history of EES introduction

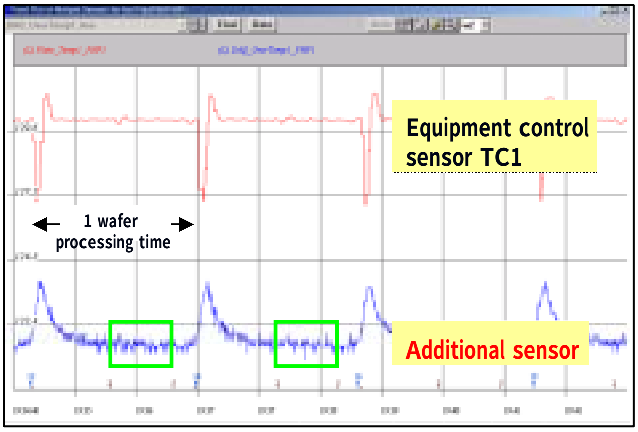

Fig. 2 Detection ability assurance through the addition of another sensor

設備Grp.	対象号機	機種	WDQC	EQC	MQC
TESO-CU	E13X	Telius-SC	2回/週	1回/週	メンテ

故障モード	表面ダスト	形状異常	チッピング
想定原因 (複数あれば列を分ける)	デポ剥れ Cleaning不足 Seasning不足	エッチングレート異常 (Gas,圧力,Power,温度,ESC)	搬送系異常 (位置ズレ, 搬送速度異常)
検知方法 (複数あれば①②・・・で記入)	①WDQC ②ILM	①PQC SEM ②PQC MES (DxSET)	①重度：搬送系インターロック ②軽度：無し
現状の検知感度 (上記検知方法①②・・・に対し各々) ※後工程検知の場合 3工程以内を1日とする (分類はコメント参照)	①！ ②◎	①◎ ②◎ ③◎	①◎ ②×
判定 (1日以内で異常検知できるか) OK/NG	OK	OK	OK
検知方法	ILM	PQC SEM/MES	搬送系インターロック
感度分類	3	3	1
【参考】上記検知感度 (Best項目) における異常発生時の対象ロット数 (Max)	①15Lot(5Lot×3日) ②5Lot(5Lot×1日)	①5Lot ②5Lot ③1Lot	①1s ②xx
【参考】品質影響度	歩留低下	信頼性	NG
判定OKにするための強化策/現状コメント	無し	無し	Post_Alignによる簡易Edge検査
検知に用いるFDC/Alarm 内容	対象項目	対象項目	対象項目

RSX対象作業	CTQ	PQCまでの工程数	SQCまでの工程数	APC Position	APC Position	APC Position

Fig. 3 Process factor analysis in correspondence to product quality

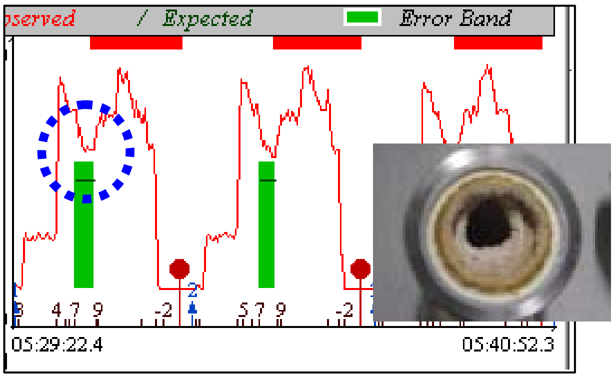

Fig. 4 CVD pump defect detection

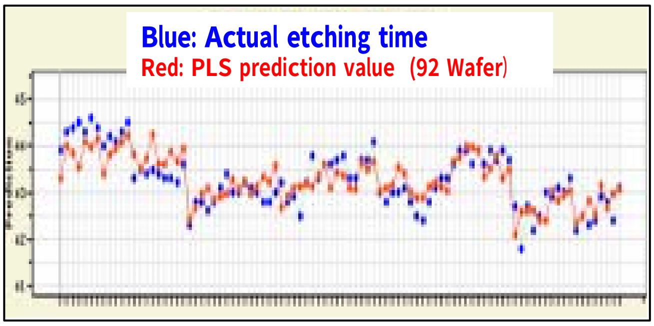

Fig. 5 Equipment QC reduction via etching rate prediction

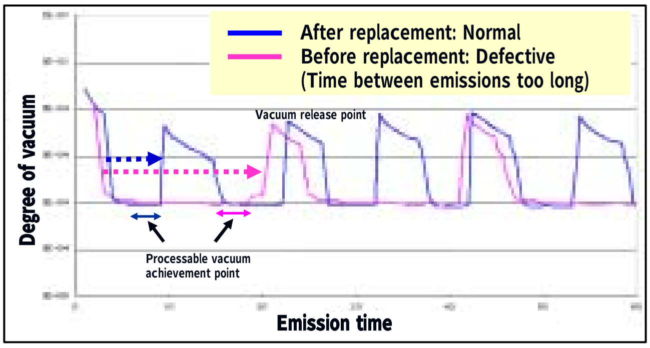

Fig. 6 Exhaust capacity evaluation using EEQA at ion implantation equipment start-up